SECTION 6- SPINE ASSEMBLY

6.1 Spine Assembly Description and Features

The spine assembly for the THOR dummy includes the mechanical components from the neck pitch change mechanism to the pelvis / lumbar mounting block. The advanced spine assembly includes the following features: two pitch change mechanisms, two flex joints, and updated instrumentation including a thoracic load cell, triaxial accelerometers at T1 and T12, and four angular orientation (tilt) sensors. The complete spine assembly is shown in **Figure 6.1**.

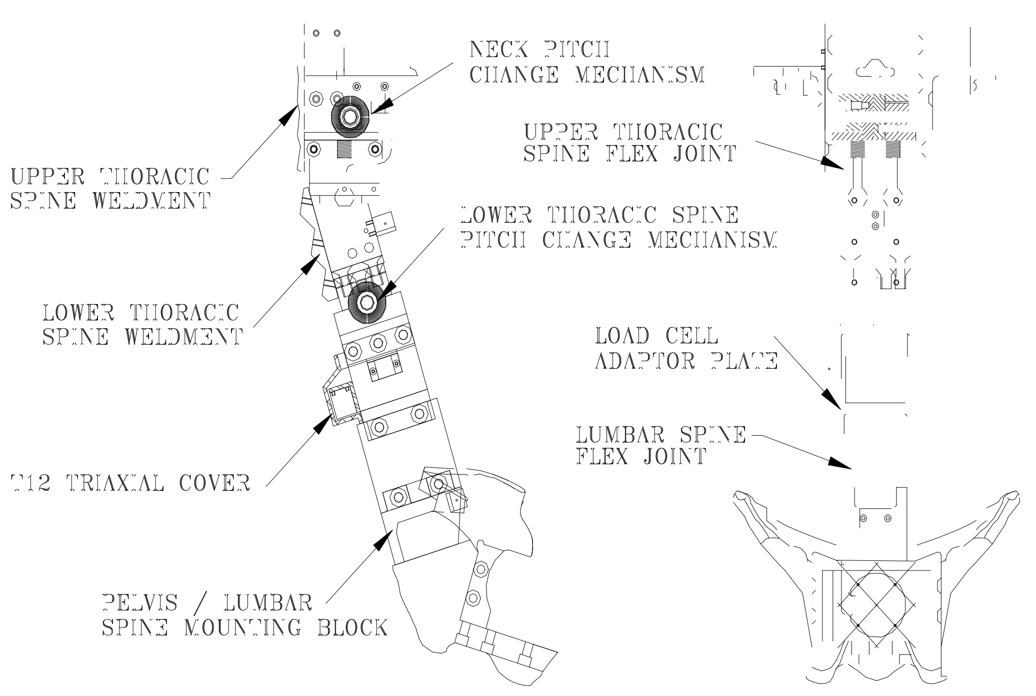

Figure 6.1- Spine assembly

One of the primary goals of the new spine assembly is to enable the dummy to assume several different seated postures for testing. The range of seating postures allows the dummy to accommodate various automotive environments. The THOR spine assembly is capable of adjusting into the four major seating postures that have been defined through a postural study (Reynolds). The adjustment capability is provided by the neck and lower thoracic spine pitch change mechanisms. The neck pitch change mechanism is centered at the approximate location of the anthropomorphic landmark defined by the C7 / T1 joint. The lower thoracic spine pitch change mechanism is centered at the approximate location of the anthropomorphic landmark defined by the T11 / T12 joint. The seating posture of the THOR dummy can be adjusted in three-degree increments by rotating the spine segments with the pitch change mechanisms.

The second feature of the THOR spine assembly is the integration of two flexible joints into the assembly to provide a degree of bending and flexibility. The lumbar spine flex joint has been redesigned to reduce the amount of space required for this joint. A new upper thoracic flex joint has been added to provide additional flexibility to the spine.

The final feature of the THOR spine assembly is the integration of several sensors to provide data about the orientation, acceleration, forces, and moments of the spine assembly, as shown in **Figure 6.2**. The Thoracic Spine Load Cell (Denton: Model B-1911) has been incorporated into the spine assembly at the approximate location of the anthropomorphic landmark defined by the T12/L1 joint. This load cell provides the forces about all three primary axes and the moment about the X and Y axes. Mounting plates for triaxial accelerometer units are bolted to the spine assembly at the approximate location of the anthropomorphic landmark T1 and T12. These accelerometers can be used provide information about the spine acceleration along the three principle axes. In addition, four static tilt sensors have been attached to various components of the spine assembly to provide information on the posture of the dummy prior to testing. The angular orientation of the dummy spine is processed through a tilt sensor readout box which provides the laboratory technician with a two dimensional orientation of the various spine components during the test setup.

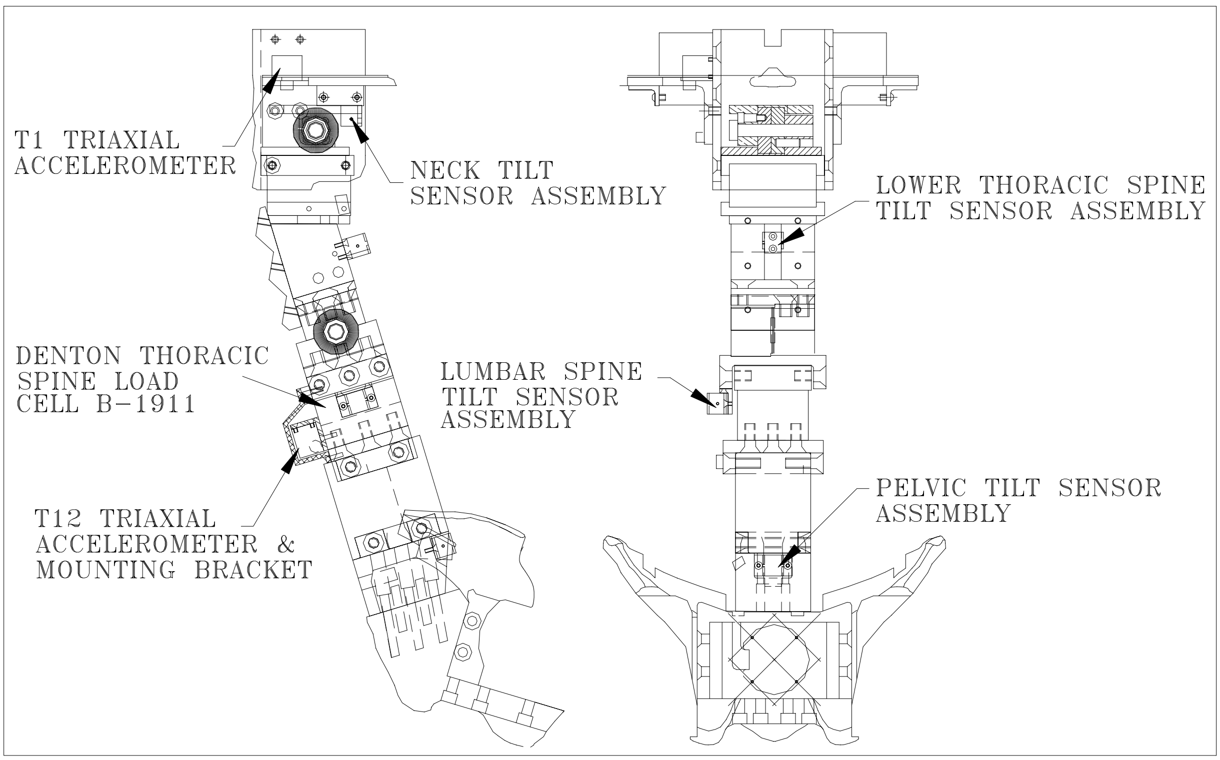

Figure 6.2-Spine instrumentation locations

6.2 Spine Assembly

6.2.1 Parts List

The parts list and all quantities for the spine assembly are listed in Appendix I - Bill of Materials under the Spine subsection. Refer to drawing T1SPM000 in the THOR drawing set for a detailed mechanical assembly drawing. **Figure 6.3** is a drawing of the exploded spine. Some of the hardware was not included in order to better illustrate the assembly.

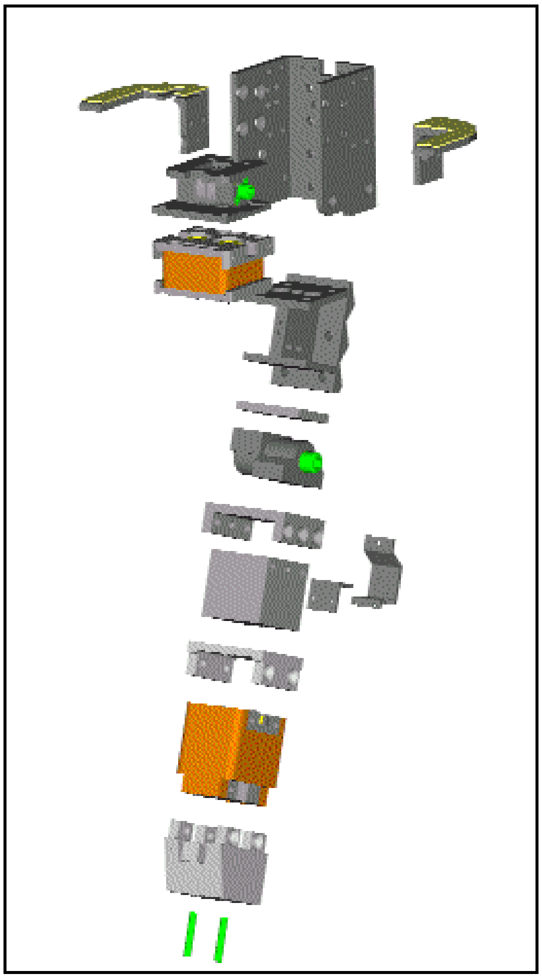

Figure 6.3- Exploded spine assembly

6.2.2 Assembling the Spine Components

The following procedure is a step-by-step description of the assembly procedure for the spine components. The numbers noted in ( ) refer to a specific drawing / part number for each part. The numbers noted in the { } indicate the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values.

1. The Pelvic Tilt Sensor Assembly (T1SPM932 & T1INM510) is attached to the front of the Pelvis / Lumbar Spine Mounting Block (T1SPM800) using two #4-40 x 3/8" FHSCS {1/16} as shown in **Figure 6.4**. The tilt sensor wire is routed to the left-side of the Pelvis/Lumbar Spine Mounting Block and is strained relieved by a 1/8" wire clamp using a #4-40 x 3/8" BHSCS {1/16} as shown in **Figure 6.4**.

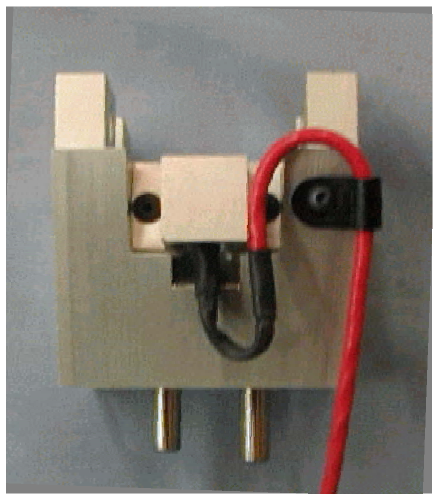

Figure 6.4- Pelvis/ Lumbar Mounting Block assembly

2. The pelvis / lumbar spine mounting block is attached to the Pelvis Assembly (T1PLM000) using the four 1/4-20 x 1" SHCS {3/16}, as shown in **Figure 6.5**. The mounting block is positioned with the tilt sensor assembly toward the front of the pelvis assembly. The wire from the right pelvic acetabular load cell is routed underneath the Pelvis/Lumbar Mounting Block Assembly (T1SPM800) in the groove at the top right-side of the Machined Pelvis (T1PLM010) and out the back of the spine. The wire from the pelvis tilt sensor and the left pelvic acetabular load cell is grouped together and is routed underneath the Pelvis/Lumbar Mounting Block in the groove on the top left-side of the Machined Pelvis (T1PLM010) and out the back of the spine.

WARNING: Care must be exercised to avoid pinching any of the wires from the pelvic instrumentation during this step.

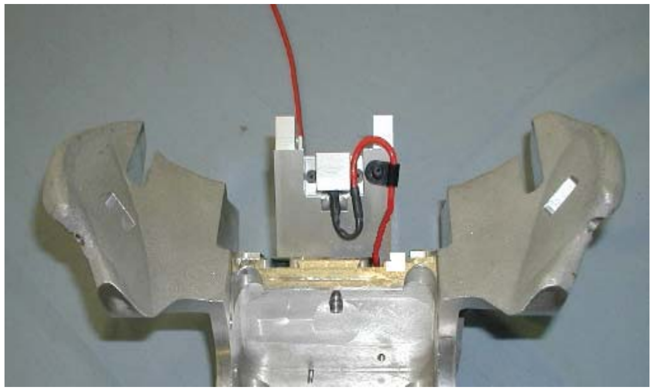

Figure 6.5-Attachment of Pelvis/ Lumbar Mounting Block on Pelvis showing wire routing

3. The Lumbar Spine Flex Joint (T1SPM700) is attached to the top of the pelvis / lumbar spine mounting block using four 5/16-18 x 3/4" FHSCS-NP {3/16}, as shown in **Figure 6.6**. The flex joint may be inserted into the mounting block with either side facing toward the front.

NOTE: Step 3 of the assembly assumes that the cables in the flex joint have been properly adjusted as described in Section 6.3.

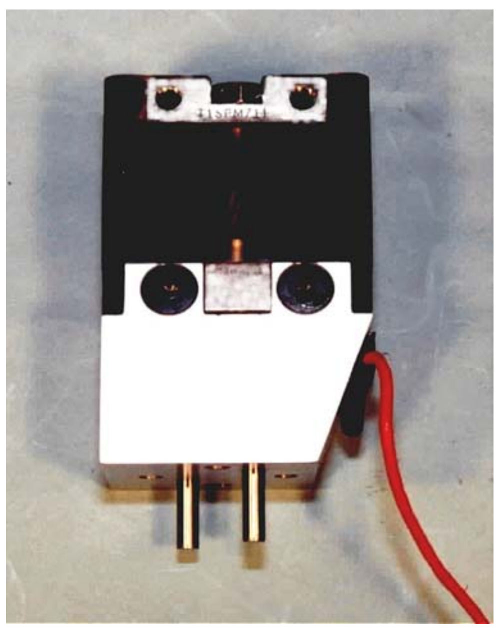

Figure 6.6- Lower Flex Joint assembled to Pelvis / Lumbar Mounting Block

4. The Load Cell Adaptor Plate (T1SPM610) is attached to the bottom of the Denton Thoracic Spine Load Cell Model B-1911 (or the non-active thoracic spine load cell - T1SPM611) using four 5/16-18 x 3/4" FHSCS-NP {3/16}, as shown in **Figure 6.7**. The load cell adaptor plate should be oriented so that the two #4-40 tapped holes are positioned toward the rear of the load cell where the instrumentation cables exit.

NOTE: The two #4-40 tapped holes will be used to attach the T12 triaxial accelerometer cover in step 18.

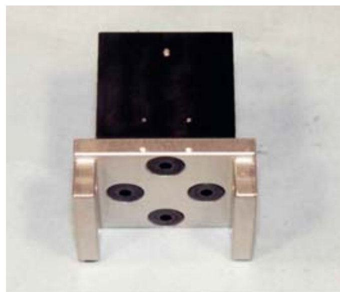

Figure 6.7- Load Cell Adaptor Plate attached to T12 Load Cell

5. The Load Cell Adaptor Plate / Load Cell Assembly (T1SPM600), completed in Step 4, is attached to the lumbar spine flex joint using four 5/16-18 x 3/4" FHSCS-NP {3/16}, as shown in **Figure 6.8.**

Figure 6.8- Lower Flex Joint attached to Load Cell Adaptor

6. The lower thoracic spine pitch change mechanism (T1SPM500) is attached to the Thoracic Spine Load Cell using six 5/16-18 x 1" FHSCS-NP {3/16}, as shown in **Figure 6.9**. The head of the ½-20 x 2.5 S.H.C.S. adjustment bolt in the pitch change mechanism should be oriented to the right-hand side of the spine assembly.

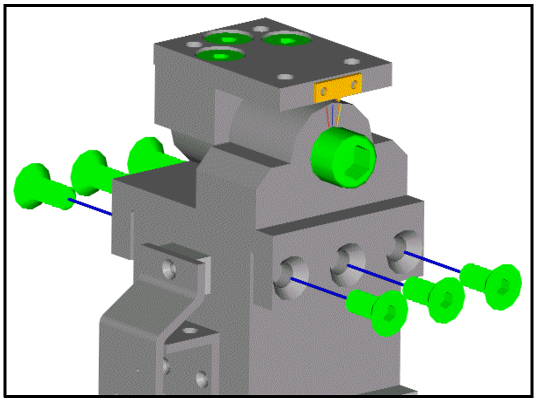

Figure 6.9- Lower pitch change to T12 Load Cell

7. The Lumbar Spine Tilt Sensor Mounting Bracket (T1SPM931) is attached to the right-hand side of the Lower Thoracic Spine Pitch Change Mechanism using two #4-40 x 3/8" FHSCS {1/16}. The mounting holes are located on the bottom right-hand side of the pitch change mechanism lower bracket. The Tilt Sensor Housing (T1SPM932) with tilt sensor are then mounted to the bracket using two #4-40 x 1/4" FHSCS {1/16}. The tilt sensor wire must exit out the bottom of the tilt sensor housing, toward the pelvis. The wire is secured to the top right-side of the Load Cell Adaptor Plate using a 1/8" wire clamp and #4-40 x 3/8" BHSCS, as shown in **Figure 6.10**.

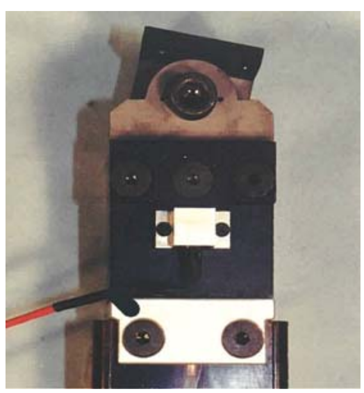

Figure 6.10- Tilt sensor and mounting bracket installed

8. The Lower Thoracic Spine Weldment (T1SPW400) is attached to the top plate of the lower thoracic spine pitch change mechanism using two 5/16-18 x ½" FHSCS-NP {3/16} on the left-side and two 5/16-18 X 5/8" FHSCS-NP {3/16} on the right-side, as shown in **Figure 6.11**.

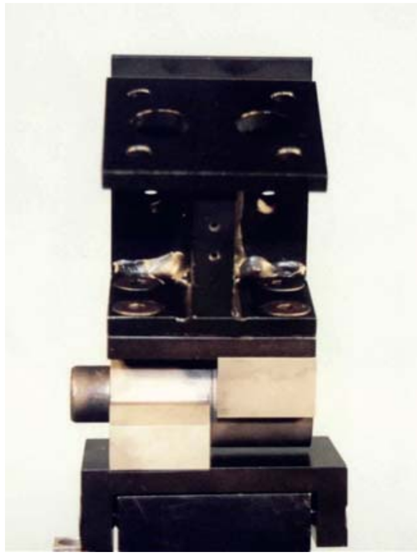

Figure 6.11- LTS Weldment mounted to Lower Pitch Change

9. The Lower Thoracic Spine Tilt Sensor Assembly is attached to the Lower Thoracic Spine Weldment using two #4-40 x 3/8" FHSCS {1/16}. The instrument wire is routed up along the front of the tilt sensor housing and secured with a zip tie through the hole in the lower thoracic spine weldment, as shown in **Figure 6.12**. (This wire is then routed to the left-side of the Thorax CG Triaxial Accelerometer Bracket (T1TXM210), as described in the Section 7 - Thorax Assembly).

NOTE: It is necessary to remove the tilt sensor (T1INM510) from the LTS Tilt Sensor Housing (T1SPM910) by loosening the two #2-56 set screws on the side of the tilt sensor mount and sliding the tilt sensor out. This provides access to the recessed mounting holes in the tilt sensor mount, thus allowing it to bolt to the lower thoracic spine weldment. Finally, replace the tilt sensor into the mount and tighten the #2-56 set screws to secure it in place. The line on the tilt sensor must be oriented toward the front of the dummy so that the line on the tilt sensor intersects to form a straight line with the scribed line at the front of the LTS Tilt Sensor Housing as described in detail in the Section 15.9 - Tilt Sensors.

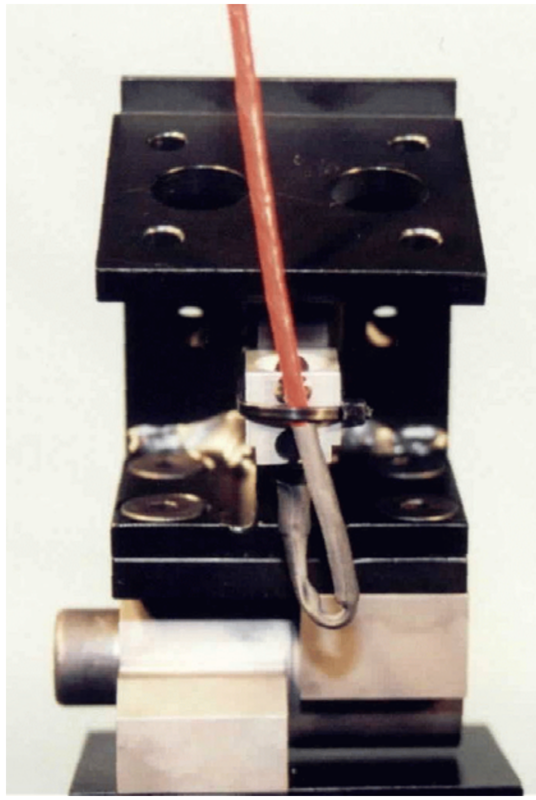

Figure 6.12- LTS Tilt Sensor assembled to LTS Weldment

10. The Upper Thoracic Spine Flex Joint (T1SPM300) is attached to the Lower Thoracic Spine Weldment (T1SPW400) using four 1/4-20 x ½" SHCS-NP {3/16}. The flex joint must be oriented with the smaller bottom plate (T1SPM312) toward the lower thoracic spine weldment and the #10-32 tapped holes on the side closer to the front of the dummy, as shown in **Figure 6.13**.

NOTE: Step 10 of the assembly assumes that the cables in the flex joint have been properly adjusted as described in Section 6.3- Adjusting the Spine Assembly.

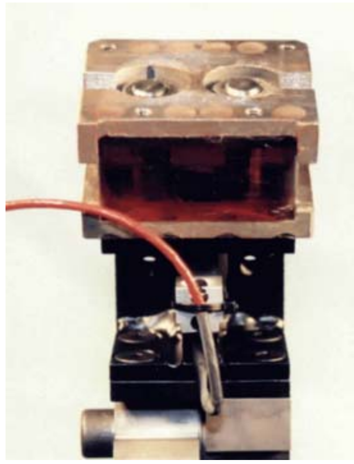

Figure 6.13- Upper Flex Joint assembled to LTS Weldment

11. The Neck Tilt Sensor Assembly (T1SPM911 and T1INM510) is attached to the Neck Pitch Mechanism (T1SPM200) using two #4-40 x 3/8" FHSCS {1/16}. The tilt sensor wire must exit in the downward direction and is secured to the hole provided in the tilt sensor housing using a 1/8" wire clamp, #4 washer, and #4-40 x 3/8 SHCS {3/32} , as shown in **Figure 6.14**.

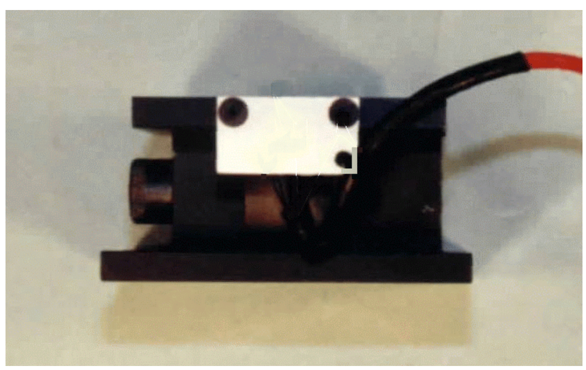

Figure 6.14- Neck Tilt Sensor and Mount

12. The Neck Pitch Change Mechanism (T1SPM200) is attached to the upper thoracic spine flex joint using four 1/4-20 x ½" SHCS-NP {3/16}. The pitch change mechanism must be oriented with the adjustment bolt toward the right-side of the dummy, as shown in **Figure 6.15**. It may be necessary to loosen the pitch change mechanism to allow rotation of the upper plate, thus providing access to all of the mounting holes.

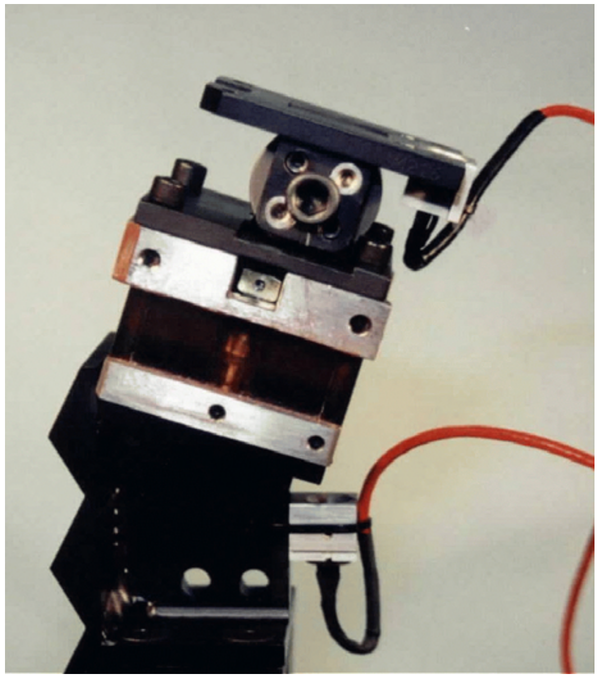

Figure 6.15- Neck Pitch Change Mechanism assembled to Upper Flex Joint

13. The Neck Tilt Sensor cable is routed through the hole in the rear of the upper thoracic spine weldment, as shown in **Figure 6.16**.

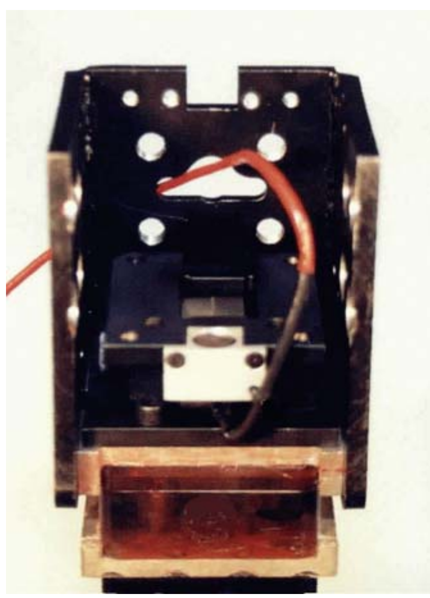

Figure 6.16- Neck Tilt Sensor wire routing

14. The Left and Right Rib Supports (T1SPM111 & T1SPM112) are attached to the Upper Thoracic Spine Weldment using four 1/4-20 x ½" FHSCS-NP {5/32}. The Upper Thoracic Spine Weldment (T1SPW120) is attached to the upper thoracic spine flex joint using four 1/4-20 x ½" FHSCS-NP {3/16}, as shown in **Figure 6.17**.

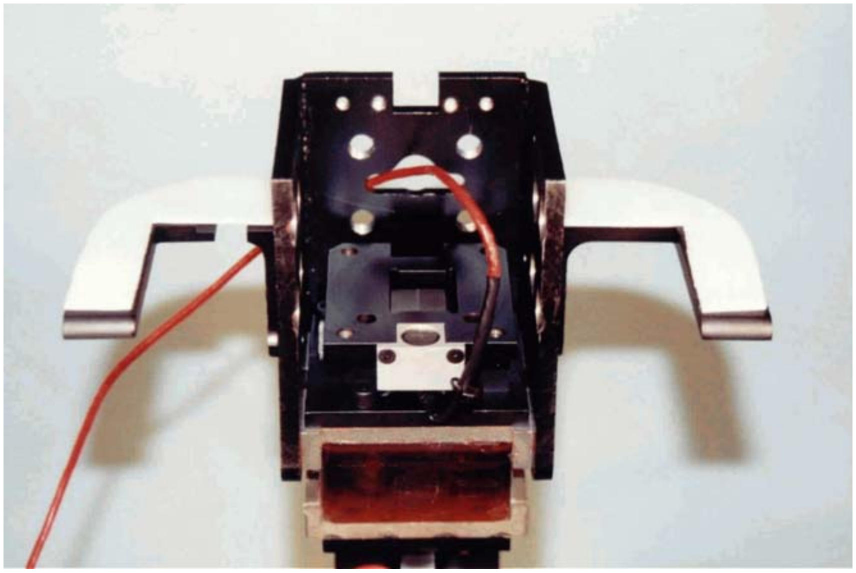

Figure 6.17- Complete Upper Thoracic Spine assembled to the Upper Flex Joint

15. A triaxial accelerometer unit can be attached near the T1 level to the upper thoracic spine weldment on the outside right-hand surface. The THOR dummy was designed to accept mounting plates for both the triaxial cube and tri-pack accelerometer configurations. It may be necessary to temporarily remove the Right Side Rib Support (T1SPM112) during T1 triaxial installation and removal. The mounting procedure for each type of triaxial accelerometer is explained in detail below:

    <u>Triaxial cube type accelerometers</u>: Refer to drawing T1SPM100 for additional details. This type of triaxial accelerometer is a one piece unit (T1INM120). The unit is attached to the right side of the upper thoracic spine weldment using two #4-40 x 3/8" FHSCS {1/16}. The stamped markings on the unit are oriented in the following manner: +Y down, +X rear, +Z right. The axes must be corrected to the SAE convention in the DAQ system wiring. The wire from the triaxial cube exits down and is secured to the right side Rib Support (T1SPM112) using a 1/8" wire clamp and a #6-32 x 3/8" BHSCS {5/64}. **Figure 6.18** shows the completed installation of this unit.

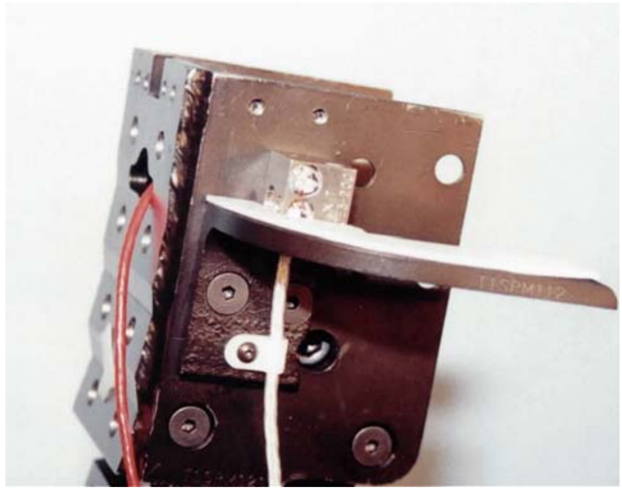

Figure 6.18- T1 Triaxial Accelerometer installed

Tri-Pack type accelerometers: Refer to drawing T1SPM101 for additional details. This type of triaxial accelerometer consists of a Tri-Pack Block (T1INM130) which holds three uniaxial accelerometers (T1INM110) on the outer surface. The three uniaxial accelerometers are mounted on the tri-pack block using six #0-80 x 1/4" SHCS {0.05}. The Tri-Pack Mounting Plate (T1SPM114) is mounted to the right side of the upper thoracic spine weldment using the lower left and upper right mounting holes, as shown in **Figure 6.19**.

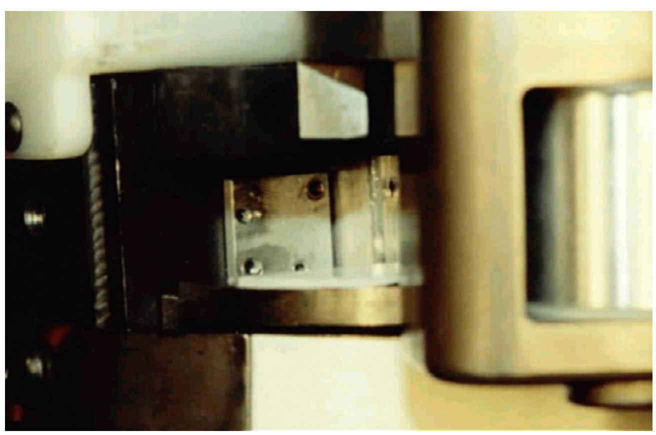

Figure 6.19- UTS tri-pack mounting plate

The instrumented tri-pack block is mounted to the mounting plate using two #2-56 x 9/16" SHCS {5/64}. The orientation of the accelerometers is shown in **Figure 6.20**. The uniaxial accelerometers are oriented on the tri-pack block in the following manner: +X forward, +Y right, +Z up. The axes must be corrected to the SAE convention in the DAQ system wiring. The wires from the uniaxial accelerometers are secured to the Right Side Rib Support (T1SPM112) using a 3/16" wire clamp and a #6-32 x 3/8" BHSCS {5/64}.

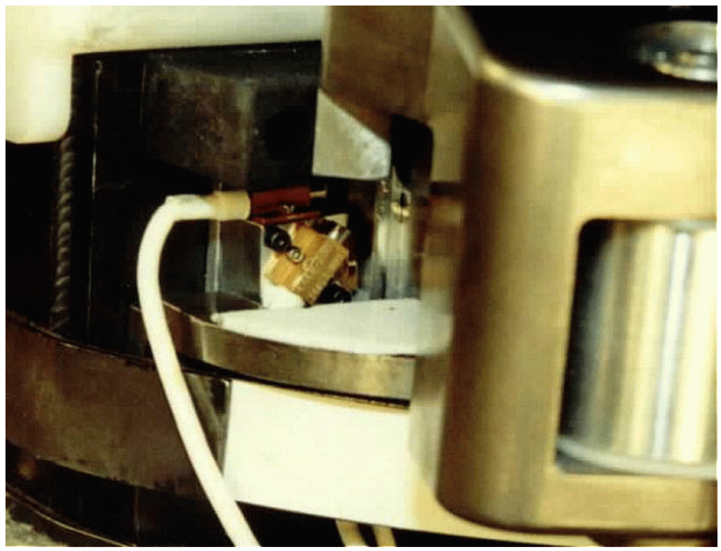

Figure 6.20- UTS tri-pack accelerometer installed

16. A triaxial accelerometer unit can be attached near the T12 level to the rear of the T12 thoracic spine load cell. The THOR dummy was designed to accept mounting plates for both the triaxial cube and tri-pack accelerometer configurations. The mounting procedure for each type of triaxial accelerometer is explained in detail below:

    Triaxial cube type accelerometers: Refer to drawing T1SPM920 for additional details. This type of triaxial accelerometer is a one piece unit (T1INM120). The T12 Triaxial Accelerometer Mounting Bracket (T1SPM920) is attached to the rear of the Denton Thoracic Spine Load Cell using two #4-40 x 3/8" FHSCS {1/16} as shown in **Figure 6.21**. The stamped markings on the unit are oriented in the following manner: +X forward, +Y right, +Z down, which conforms to the SAE coordinate system. The wire from the triaxial cube is joined to the main wire bundle running down along the rear of the spine.

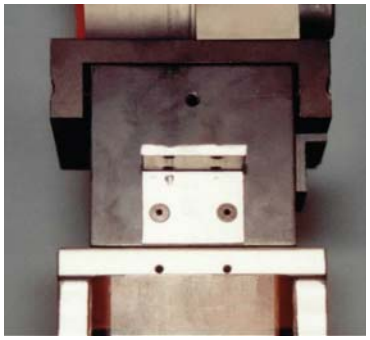

Figure 6.21- T12 triaxial mounting plate

Tri-Pack-type accelerometers: Refer to drawing T1SPM921 for additional details. This type of triaxial accelerometer consists of a Tri-Pack Block (T1INM130) which holds three uniaxial accelerometers (T1INM110) on the outer surface. The three uniaxial accelerometers are mounted on the tri-pack block using six #0-80 x 1/4" SHCS {0.05}. The T12 Tri-Pack Mounting Adaptor (T1SPM933) is mounted onto the back of the T12 load cell using two #4-40 x 3/8" FHSCS {1/16}. The instrumented tri-pack block is mounted to the T12 Tri-Pack Mounting Adaptor on the back of the T12 load cell using two #2-56 x 9/16" SHCS {5/64}. The accelerometers are oriented as follows: +X rear, +Y left, and +Z up as shown in **Figure 6.22**. The installation of this unit is completed in steps 17 & 18 below. The axes must be corrected to the SAE convention in the DAQ system wiring. The wires from the triaxial cube are joined to the main wire bundle running down along the rear of the spine.

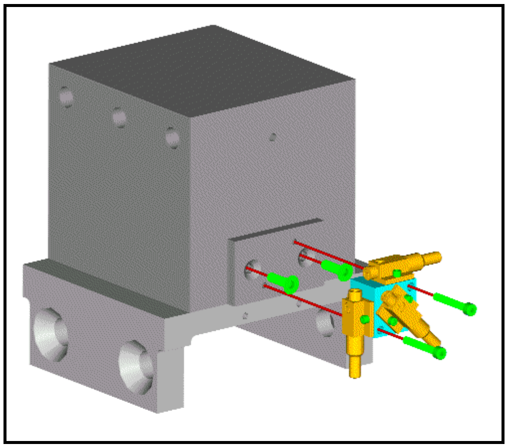

Figure 6.22- Tri-pack accelerometer installed on T12 Load Cell

17. The T12 Triaxial Accelerometer Cover (T1SPM924) is attached to the Thoracic Load Cell (T1INM330) using one #6-32 x 5/8" FHSCS {5/64} which passes through the hole in the cover, through the wire clamp on the back of the load cell, and into the load cell.

NOTE: The instrumentation wires from the back of the load cell must be clamped in place with the wire clamp to provide the required strain relief.

18. The T12 triaxial accelerometer cover is attached to the load cell adaptor plate using two #4-40 x 3/8" FHSCS, as shown in **Figure 6.23**. The accelerometer is oriented as follows: +X forward, +Y right, +Z down.

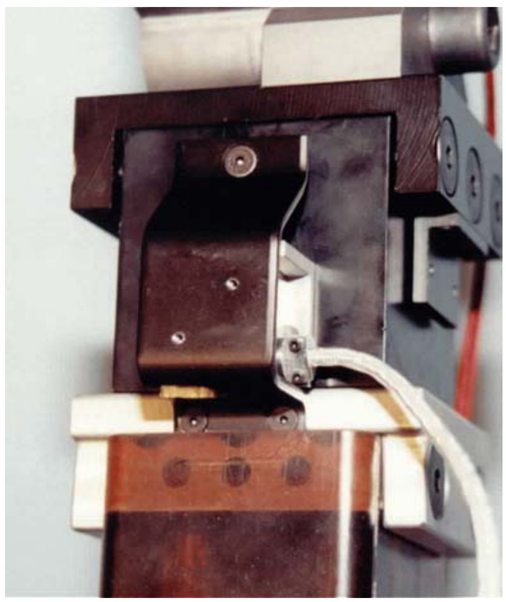

Figure 6.23- T12 triaxial cover mounted to spine (triaxial accelerometer installed)

6.2.3 Connecting the Spine to the Pelvis

The following procedure is a step-by-step description of how to connect the spine assembly to the completed Pelvis Assembly (T1PLM000). The numbers provided in ( ) refer to a specific drawing / part number of each particular part. The numbers noted in { } after a bolt size indicates the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values. For additional details, refer to Section 6.2.1, Steps 1 through 3.

1. Remove the Pelvis Lumbar Mounting Block (T1SPM810) from the lumbar flex joint (T1SPM700) by removing four 5/16-18 x 3/4" FHSCS-NP {3/16} from the side.

2. The pelvis / lumbar spine mounting block is attached to the Pelvis Assembly (T1PLM000) using the four 1/4-20 x 1" SHCS {3/16}, as shown in **Figure 6.5**. The mounting block is positioned with the tilt sensor assembly toward the front of the pelvis assembly. The wires from the pelvic acetabular load cells and pelvis tilt sensor must be routed in the grooves provided in the pelvis assembly which is underneath the mounting block's mounting surface.

WARNING: Care must be exercised to avoid pinching any of the wires from the pelvic instrumentation during this step.

---

3. Reverse step 1 to reattach the Pelvis Lumbar Mounting Block (T1SPM810) to the Lumbar Flex joint (T1SPM700).

6.2.4 Connecting the Neck to the Spine

The following procedure is a step-by-step description of how to connect the neck assembly to the completed spine assembly at the top plate of the Neck Pitch Change Mechanism Assembly (T1SPM200). The numbers provided in ( ) refer to a specific drawing / part number of each part. The numbers noted in { } after the bolt size indicate the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values. For additional details refer to Section 5.2.4.

1. Pass the lower neck load cell instrumentation wires out through the hole at the top of the Upper Thoracic Spine Weldment (T1SPM100).

2. Secure the lower neck load cell to the top plate (T1SPM216) of the neck pitch change mechanism using four 1/4-20 x 5/8" SHCS- NP {3/16}.

6.3 Adjusting the Spine Assembly

6.3.1 Adjustment Procedure for Lower Thoracic Spine Pitch Change Mechanism

The following is a step-by-step procedure for adjusting the seating posture of the THOR dummy using the lower thoracic spine pitch change mechanism. This adjustment changes the angle between the lumbar spine components and the lower thoracic spine components. The adjustment is made in three-degree increments by disengaging the teeth and rotating the two halves of the unit.

1. Disengage the teeth of the two halves of the "star pattern" by loosening the central ½-20 x 2.5" SHCS thru bolt {3/8}, as shown in **Figure 6.24**. This bolt can be accessed from the right-hand side of the dummy using the long "T-Handle" ball end hex wrench. Unzip the right jacket zipper and insert the hex wrench into the bolt head, just

below the level of rib #7. This bolt must be loosened enough to disengage the teeth from the mating halves of the "star pattern." A visual inspection from the rear of the dummy may be made to determine if the teeth have been successfully disengaged.

WARNING: The unit's teeth will be seriously damaged if the adjustment is made before they are completely disengaged.

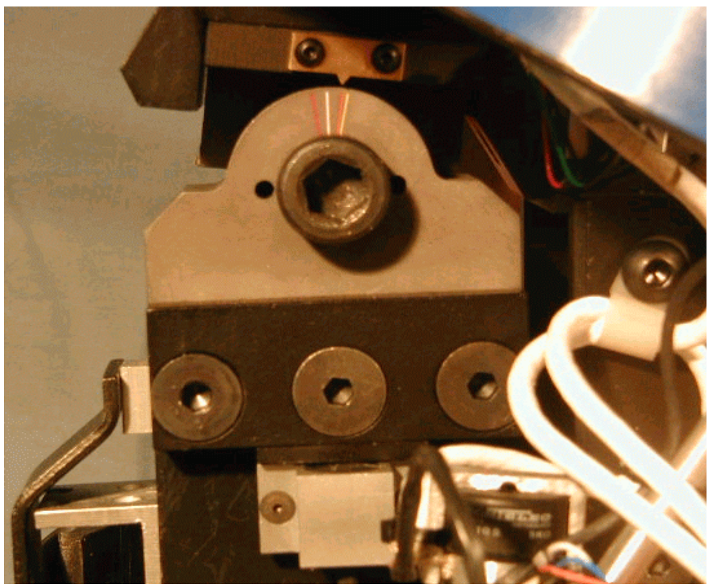

Figure 6.24-LTS pitch change mechanism adjustment

2. Adjust the posture to the desired setting by rotating the two halves of the pitch change mechanism with respect to one another. The desired posture setting can be determine by aligning the pointer on the Lumbar Pitch Change Indicator (T1SPM523) with one of the marks scribed on the Lumbar Spine Pitch Change Star Wheel - Right Side (T1SPM522). Each of the scribed lines corresponds to a spinal posture setting for the dummy as shown in **Figure 6.25**. In addition, the scribed lines are color coded to make each of the posture settings easily identified.

WARNING: Ensure that the teeth are meshed and engaging properly before proceeding.

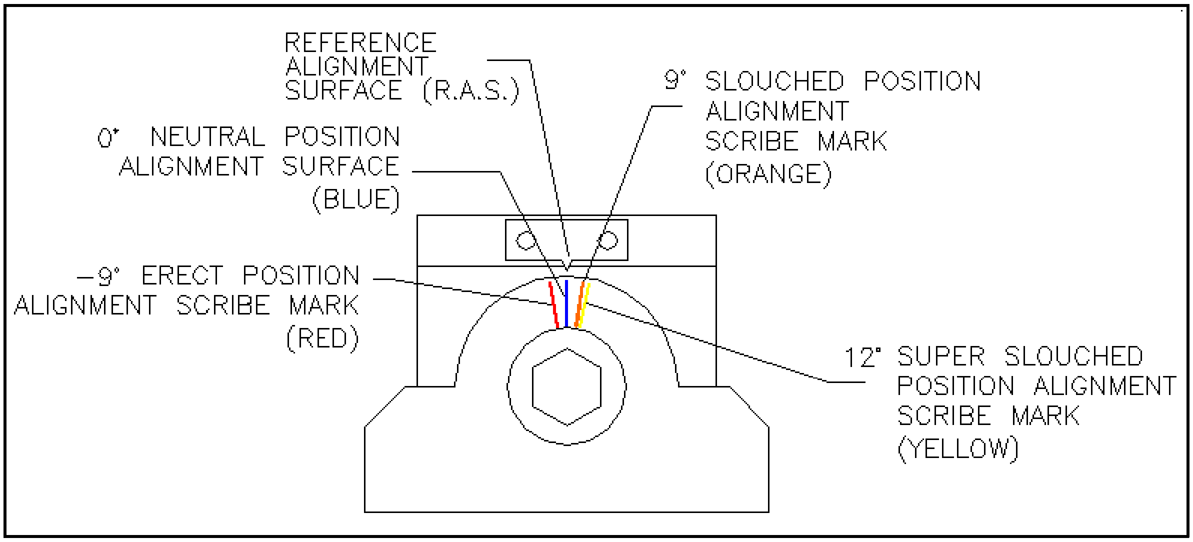

Figure 6.25- Adjustment marks and locations (right-side view)

3. Tighten the central ½-20 x 2.5" SHCS thru bolt {3/8} to 50 ft-lb to engage the teeth and lock the mechanism into place.

6.3.2 Adjusting the Neck Pitch Change Mechanism

The following is a step-by-step procedure for adjusting the head and neck position of the THOR dummy using the neck pitch change mechanism. This adjustment changes the angle between the neck and the upper thoracic spine components. The adjustment is made in three-degree increments by disengaging the teeth and rotating the two halves of the unit.

1. Disengage the teeth of the two halves of the “star-pattern” by loosening the 3/8-24 SHCS {5/16} as shown in **Figure 6.26**. This bolt can be accessed from the right side of the dummy using the long 5/16 “T-Handle” ball-end hex wrench. This bolt must be loosened enough to disengage the teeth from the mating halves of the “star pattern.” The head and neck will rotate freely fore and aft when the bolt is sufficiently loosened.

WARNING: The teeth of the unit will be seriously damaged if the adjustment is made before they are completely disengaged.

---

2. Adjust the head and neck to the desired position by rotating the two halves of the pitch change mechanism with respect to one another. The desired posture setting can be determined by using the tilt sensors mounted on the neck pitch change mechanism and the lower thoracic spine to determine the change in relative angle.

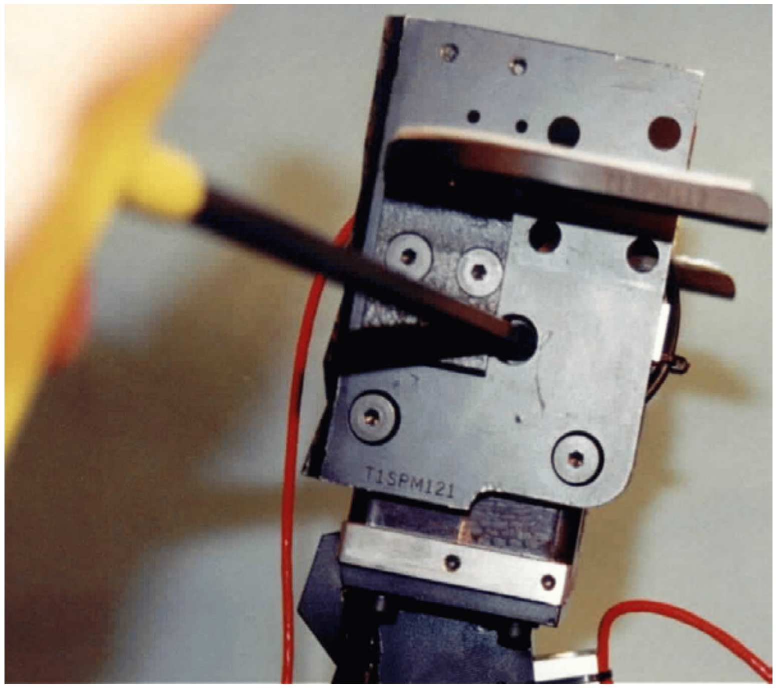

Figure 6.26 Neck Pitch Change adjustment

WARNING: Ensure that the teeth are meshed and engaging properly before proceeding.

3. Tighten the central 3/8 - 24 SHCS {5/16} to a torque of 37.5 ft-lb to engage the teeth and lock the mechanism into place.

6.3.3 Adjustment Procedure for Tightening Flex Joint Cables

The adjustment procedure is identical for correctly tightening the cables on the upper thoracic and the lumbar spine flex joints. Both of these joints use two 5/16" steel cable assembly which has a ball and shank on one end and a ½-20 threaded swage on the other end. The cables for both units are oriented so the ball and shank ends are down (i.e. toward the pelvis) and the threaded end is up to allow access from the top. The only difference between these cable assemblies is the length: the lumbar cables are 2.9", and the upper thoracic cables are 1.9". The cables must be adjusted so they are snug (i.e. no slack), but the preload on the flex joint should be very minimal.

1. Insert the two cables through the holes provided in the flex joints. The threaded ends should exit from the top of the joints. Place a ½" ID, 1.0" OD Teflon washer and a ½-20 hex thin jam nut onto the threaded ends of each cable assembly.

2. Place a 3/4" socket (½" square drive socket) onto the jam nut. Insert a slotted screw driver (3/8" tip width) inside the thru hole of the 3/4 socket so that the slotted screw driver engages the slot on the cable assembly. Attach a pair of vise grip pliers to the 3/4" socket and tighten the jam nut while holding the slotted screw driver to prevent

the cable from rotating as shown in **Figure 6.27**. Tighten the nut onto the cable assembly until the nut makes contact with the Teflon washer on top of the counterbored surface of the flex joint top plate. Continue tightening the nut, one half turn past contact between the nut and the Teflon washer. Repeat this step for the other cable.

NOTE: The cables must be adjusted so they are snug (i.e. no slack), but the preload on the flex joint should be very minimal.

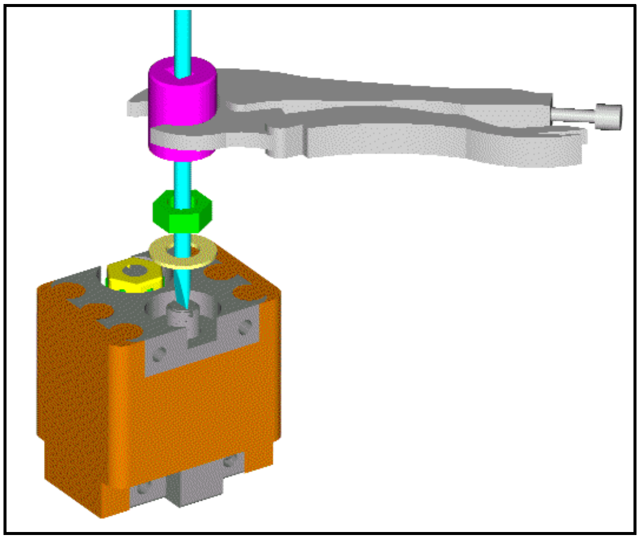

Figure 6.27- Flex joint cable installation

3. Place a Nut Cover (TISPM313) on each nut.

6.4 Wire Routing and Electrical Connections

The wire routing for the instrumentation on the spine assembly is fairly straightforward. Each instrument in this assembly will be covered individually. It may also be necessary to refer to the sections on the Thorax assembly and Instrumentation to develop a complete understanding of these instrumentation systems. Refer to **Figure 6.28** for a graphical representation of the wire routing for these instruments.

<u>T1 Triaxial Accelerometer</u>: The wire from this unit should run down the right-hand side of the spine assembly and exit between ribs #1 and #2 to join the wire bundle running along the back of the spine.

Neck Tilt Sensor Assembly: This wire is routed along the side of the neck pitch mechanism and exits through the hole in the rear of the upper thoracic spine weldment to join the wire bundle running down from the head and neck.

Lower Thoracic Spine Tilt Sensor Assembly: This wire is strain relieved at the lower thoracic spine with a zip tie and is routed along the left-side of the thoracic CG mounting bracket. This wire is then bundled with the cable from the thorax CG triaxial accelerometer and strain relieved with a 3/16" wire clamp and a #10-32 x ½" BHSCS {1/8} to the left-side of the thoracic CG mounting bracket. The wire exits between ribs #4 and #5 and joins the wire bundle running along the back of the spine.

WARNING: Great care must be used when inserting the thoracic instrumentation bracket into place to avoid pinching this wire.

Lumbar Spine Tilt Sensor Assembly: This wire is secured to the top right-side of the load cell adaptor plate using a 1/8" wire clamp and #4-40 x 3/8" BHSCS {1/16} and routed out the rear of the spine to join the wires which run down along the rear of the spine.

T12 Triaxial Accelerometer: The wires from this unit are routed to join the wires which run along the rear of the spine.

Pelvic Tilt Sensor Assembly: The wire from this unit is secured to the front left-side of pelvis/lumbar spine mounting block using a 1/8" wire clamp and #4-30 x 3/8" BHSCS {1/16}. The wire is then routed downward and under the attachment of the pelvis/lumbar spine mounting block to the pelvis casting in the left groove on the top surface of the pelvic casting. The pelvic tilt sensor is routed with the left acetabular load cell wire under the pelvis/lumbar spine mounting block and out the rear of the spine to join the wires which run down along the rear of the spine.

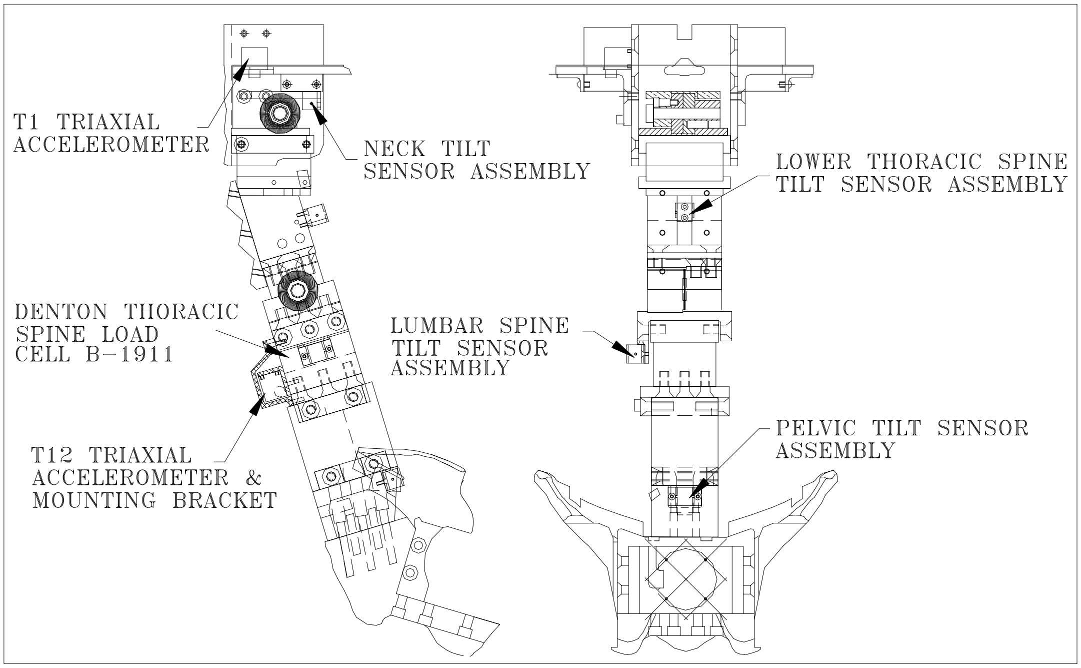

Figure 6.28-Spine instrumentation locations

6.5 Certification

6.5.1 Certifying the Lumbar Spine Flex Joint

The lumbar spine flex joint certification is a quasi-static bending test. Certification procedures for this test are described in the THOR Certification Manual - available from the manufacturer as a separate publication. Recommended certification intervals are every 3-6 months, depending on the frequency of testing and the storage conditions of the dummy. The unit can be returned to the manufacturer for certification when necessary.

6.5.2 Certifying the Upper Thoracic Spine Flex Joint

The Upper thoracic flex joint certification is a quasi-static bending test. Certification procedures for this test are described in the THOR Certification Manual which is available from the manufacturer as a separate publication. Recommended certification intervals are every 3-6 months, depending on the frequency of testing and the storage conditions of the dummy. The unit can be returned to the manufacturer for certification when necessary.

5.5.3 Certifying the Thoracic Spine Load Cell

The Thoracic Spine Load Cell (Denton Model B-1911) is calibrated by the manufacturer and requires recalibration at yearly intervals. The unit may be returned to the manufacturer for recalibration as necessary. In addition to the recommended recalibration interval, recalibration is required if the “zero load” output signal from the unloaded load cell is significantly different than that stated on the calibration sheet.

6.6. Inspection and Repairs

After a test series has been performed, several inspections should be performed to ensure the dummy's integrity has remained intact. Good engineering judgement should be used to determine the frequency of these inspections; however, the manufacturer recommends a thorough inspection upon completion of twenty tests. The frequency of the inspections should increase if the tests are particularly severe or unusual data signals are being recorded. These electrical and mechanical inspections are most easily performed during a dummy disassembly. The disassembly of the spine components can be performed by simply reversing the assembly procedure.

Although this disassembly is quite simple, some comments are provided below to assist in the process.

6.6.1 Electrical Inspections (Instrumentation Check)

Electrical inspections should begin with the visual and tactile inspection of all instrument wires from the spine instrumentation. The wires should be inspected for nicks, cuts, pinch points, and damaged electrical connections that would prevent the signals from being transferred properly to the data acquisition system. The instrument wires should be checked to ensure that they are properly strain-relieved. A more detailed check of individual instruments is covered in Section 15 - Instrumentation and Wiring.

6.6.2 Mechanical Inspection

Several components in the spine assembly require a visual inspection to determine if they are still functioning properly. A mechanical inspection should also include a quick check for any loose bolts in the main assembly. Each area of mechanical inspection will be covered in detail below. Please contact the manufacturer regarding questions about items that fail the mechanical inspection.

NOTE: The use of nylon pellet bolts was specified for the spine assembly to prevent bolts from loosening during the impact and vibrations associated with a crash pulse. If it is necessary to replace a bolt in the spine assembly, it is advantageous to use a new bolt with a fresh pellet. Reusing old pellet bolts will lessen their effectiveness.

<u>Neck Pitch Change Mechanism:</u> The following checklist should be used when inspecting the neck pitch change mechanism for post-test damage:

- This assembly should be inspected to ensure that the teeth of the mating “star patterns” are still engaged and held tightly against one another. If the teeth are loose, the mechanism must be disassembled and inspected for damage to the mating teeth.
- The center adjusting bolt should be checked for a proper torque of 37.5 ft-lb.

<u>Upper Thoracic Spine Flex Joint:</u> The following checklist should be used when inspecting the upper thoracic flex joint for post-test damage:

- This unit should be inspected for proper cable tension as described in Section 6.3.3.
- Inspect for de-bonding between the metal plates and the urethane. If there is evidence of severe de-bonding (greater than 1/8" of de-bonding along a surface), the unit should be replaced.

Lower Thoracic Spine Pitch Change Mechanism: The following checklist should be used when inspecting the lower thoracic spine pitch change mechanism for post-test damage:

- This assembly should be inspected to ensure that the teeth of the mating "star patterns" are still engaged and held tightly against one another. If the teeth are loose, the mechanism must be disassembled and inspected for damage to the mating teeth.
- The ½-20 x 2.5" SHCS center bolt should be checked for a proper torque of 50 ft-lb.

Lower Thoracic Spine Flex Joint: The following checklist should be used when inspecting the lower thoracic spine flex joint for post-test damage:

- This unit should be inspected for proper cable tension as described in Section 6.3.3.
- Inspect for de-bonding between the metal plates and the urethane. If there is evidence of severe de-bonding (greater than 1/8" of de-bonding along a surface), the unit should be replaced.